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Full Length Research

Effect of testosterone administration on the eating and mating behaviours of female albino rats

Okon A. Umoren* and Kingsley C. Opiti

Department of Psychology, Faculty of Social Sciences, University of Uyo, Uyo, Nigeria.

*Corresponding author. Email: ketexnorm45@gmail.com

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ABSTRACT: The study investigated the effect of testosterone administration on the eating and mating behaviour of female albino rats. Nine (9) female Wister (albino) rats and three (3) stimulus male albino rats were obtained from the Faculty Pharmacy, University of Uyo, Uyo. The female albino rats weighed 165 to 215 g before administration of testosterone, and 173 to 235 g during the experimental week. The age range of the rats was from 10 to 12 weeks with a mean age of 11 weeks. A within-subject design was used in the study, with a judgmental/purposive non-probability sampling technique adopted. The females were grouped in threes and labelled group 1, group 2, and group 3 while the 3 males were housed in one cage and labelled accordingly. Before the commencement of the experiment, the rats were allowed to acclimatize for a period of two weeks of which food and waters were given *ad libitum*. After the first nine days, two female albino rats were sampled from the cages – group 1 (rats B and C), group 2 (rats D and E), and group 3 (rats G and H) for blood samples collection to determine their testosterone levels before administration of testosterone propionate. During the experiment, the females' rats were administered difference level of testosterone concentration. Group 1 was administered 0.5 ml testosterone concentration (low dose), group 2 received 1 ml testosterone concentration (medium dose), and group 3 received 1.5 ml testosterone concentration (high dose). Thereafter, testosterone analysis was carried out on the blood samples collected from the female rats; testosterone concentration in the rats after administration was greater than testosterone concentration before administration. The paired sample t-test and one-way MANOVA was used to analyse the data generated. Results obtained showed that when testosterone levels of the female albino rat increased following testosterone administration, their mean eating behaviour increased from 36.77 to 85.44, while their mean mating behavior also increased from 34.44 to 44.88. Thus, the H_1 paired sample t-test showed a t-value of -3.091 with df of 8. The result was significant with $p<0.0005$, so H_1 was accepted. For H_2, t-value was also significant at $t = -2.74$, $p<0.005$, df of 8 and also accepted. H_3 was also significant and accepted at [f (2, 8) = 21.57; p < 0.05] and [F = (2, 8) 7.706; p < 0.05] respectively. In conclusion, the female albino rats eat more after testosterone administration. They also engaged more in mating behaviour after testosterone administration. Hence, the study recommends that married women who have a sexual desire should use testosterone replacement therapy for better results. This should, however, be used moderately.

Keywords: Albino rats, behaviour, female, eating, mating, testosterone.

INTRODUCTION

All living organisms are known to have the power to move, eat, reproduce their kind, and so forth. These characteristics are not found in non-living things. Like humans, lower animals produce sperm and semen which aid them to reproduce their kind. Scientists believe that there is more semen than sperm. According to Lepage (2015), in some animals, seminal fluid changes, sometimes the change occurs in both the bodies and behavior of these animals. In this regard, Lepage (2015) added that semen from humans can also bring about some changes in the uterus and might have wider effects on women. Also, research evidence (Robertson et al., 2009) shows that seminal fluids from fruit flies can make their females eat more, lay more eggs and be more receptive to males.

Semen is released from the male reproductive tract and contains sperm cells contributed by the seminal vesicles in

both higher and lower animals. The fluids carried in these vesicles contain fructose, amino acids, citric acid, phosphorus, potassium and hormones. In the literature, ejaculated semen from a male into a female womb contains testosterone and endorphins. Chapman et al. (1994) opine that seminal signaling is common in humans just as revealed in fruit flies. Since the semen of humans, pigs and mice affects the female reproductive tract and more, the question bothers on whether semen can also cause behavioural responses in female mammals, just as it is in fruit flies (Chapman et al., 1994). In flies, seminal proteins can directly affect behaviour because they enter the circulatory system, travelling through the body to the brain. Robertson et al. (2009), reiterates that small molecules can get into the bloodstream and that this semen can have an effect on women well beyond their reproductive tract.

The literature is awash with experiments using rats. Lopex-Espinoza et al (2016) exposed sixteen albino rats to 72 hour total food deprivation every fifteen days; food and water were freely available during non-deprivation periods. Rats completed three cycles, made up of a free access period, followed by food deprivation. Once deprivation was removed, food and water consumption increased, and body weight was recovered. According to Lopez-Espinoza et al. (2016), depriving rats from food consumption forced them to restrain their consumption of water. Results confirmed that food deprivation modified growth rate, water and food consumption. Additionally, during post-deprivation period, differences between males and females were not registered (Lopex-Espinoza et al., 2016).

Also in the literature, Sherri et al. (2017) reported that when testosterone proportionate (TP) was administered to aged ovary-intact female rats, it was discovered that appetitive and consummatory female sexual behavior increased, and that sexual solicitations, and hops and darts were facilitated by the highest TP doses. This coincided with an increase in plasma T, although these behavioural effects were not increased across time. The works of Sherri et al. (2017) still suggests that a decrease in bioactive T may explain why some women taking oral contraceptives (OCs) experience a decrease in sexual desire. Hence, the co-administration of T and estradiol (E_2) to naturally or surgically menopausal women results in a significant increase in sexual fantasies, arousal, and desire, compared with controls receiving not treatment (Sherri et al., 2017).

In the literature, it is also shown that androgens, a class of hormone (testosterone inclusive) are the most abundant of the sex hormones in women (Nyby, 2007). Not long ago, have we become aware that androgens play an important role in many aspects of the health and wellbeing of women. Many of the major biological events of a woman's life (adrenarche, menarche, sexuality, fertility, parturition, lactation, and menopause) are mediated in part by sex hormones (testosterone being the chief), yet we know relatively little about the effect of androgens in woman's lives and their well-being (Nyby, 2007).

Hormonal effects are grouped as organizational or activational (Hodgson and Glenn, 2017). Androgen receptors are distributed throughout the brain and are generally within proximity with estrogen receptors, hence, it is clear that androgens can have an activational effect on behaviour in women (Hodgson and Glenn, 2017). Lepage (2015) recently said that there are positive correlations between positive orgasm experience in women and testosterone levels, where relaxation was a key perception of the experience.

According to Parker (1970), mating behaviour refers to sexual activities surrounding insemination, which lead to successful sperm transfer by the male and uptake by the female as well as, in many species, post-copulatory male behaviours that have evolved in response to sperm competition. Mating behaviour is divided into the mounting, pair formation, courtship, copulation, insemination, and the activities immediately following insemination, including temporary pair maintenance (Alexander, 1997).

Species of sexually reproducing organisms are genetically closed systems because the gene exchange between them is impeded by reproductive isolating mechanisms (Lee, 1964). In some ways, women are typical female primates. In the broad area of their lifespan, women engage in sexual activity, reproduce at modest rates and engage in extensive parental investment, that is they have a primate's characteristically slow life history (Jones, 2011). As in many other primates, humans also form complex social groups and device sexually differentiated behaviours, both during development and in adulthood (Wallen, 2005). Following puberty (the process of sexual maturation), women mate and gestate, nurse and care for their offspring (Natalie and David, 2010).

Although human beings share many characteristics with non-human primates, humans are unique in several ways. For instance, humans have a very long juvenile period and adult life-span, both of which facilitate the accession of skills through cultural learning (Lancaster and Kaplan, 2009), perhaps because of men's investment in offspring (which is unusual among male mammals), women also engage in an extraordinary level of mating competition (Puts, 2016). That is, as benefits conferred by men often cannot be shared among women, the difference in male quality is predicted to catalyze female competition over high-quality males. This competition sometimes involves aggression and threats to aggression but generally assumes the form of mate attraction. Brown and Gordon (2008) opine that mating behaviour is characterized by the choice of mates, competition for mates, and parental care. In their opinion, Hardy et al. (2007) maintained that more research in the area of mating behaviour will help identify the characteristics that make a given species an effective biological control agent.

On the other hand, organisms engage in eating behavior to survive. According to Grimin and Steinle (2011), eating

behaviour is a multifarious interaction of physiological, psychological, social and genetic factors that impact meal timing, the quantity of food preference, and food selection. It is a broad term that encompasses food choice and motives, feeding practices, dieting, and eating-related problems such as obesity, eating disorders, and feeding disorders. What is being eaten and how it is being eaten has a tremendous influence on one's health (Lacaile, 2013).

In a multifaceted interaction of physiological process, interpreting a deficiency in energy, signals the brain that there is a need for food consumption, and when this need for food is satisfied, the brain is again signaled that food has been consumed, thus the need to terminate the hunger need (Meule and Vogele, 2013). However, Lowe and Butryn (2007) earlier suggest that the homeostatic regulation of eating is often steadily challenged and overridden by the ever-presence of food-related cues. This implies that, eating can be prompted even without hunger or lengthened beyond satiation, simply because of the omnipresence of food (Meule and Vogele, 2013).

Eating gives the organism pleasure and its necessity for survival is undebatable. Eating behaviour is dependent on complex interactions among homeostatic mechanisms, neural system and motor skill, sensory and socio-emotional capability (Gahayan, 2012). Understanding, therefore, the factors that drive food choices is crucial to addressing the diseases of obesity, diabetes, and cardiovascular disease (Grim and Steinle, 2011).

As earlier mentioned in this work, hormones play a major part in driving organisms to exhibit certain behaviours. Testosterone is a good example of hormone that drives sexual and food choices. Testosterone is a steroid hormone made from cholesterol that is secreted by the testes in men, and the ovaries and adrenal cortex in women (Mehta and Joseph, 2011). As an androgen hormone, testosterone plays a potent role in the development of secondary sexual characteristics in both males and females. In males, it is expressed through the morphological, physiological and behavioural traits (Hau and Bivessays, 2017), while in females, it is expressed as weaponry, ornamentation and aggressive behaviour (Kraaijeld et al., 2007). Apart from being responsible for the development of major secondary sexual characteristics, research evidence has shown that satisfactory testosterone levels are required for sexual health (Mehta and Joseph, 2011). In a study conducted by Anders and Watson (2016), testosterone was found to affect sexual behaviour and be affected by sexual situations and stimuli.

Testosterone is one of the key sex hormones occurring in both men and women. In men, it is mainly produced by the leading cells of the testes, while the ovaries produce it in women (Christopher et al., 2011). Besides its role in the development of secondary sex characteristics, testosterone has a well-known and important role and is of special interest in the study of socio-emotional and economic behaviour since it influences the brain in archetypical situations, such as fight, flight, mating and search and struggle for status (Christopher et al., 2011). Testosterone was found *in vivo* models, including hormone suppression, hormone restoration and hypophysectomy in a study of hormonal regulation of spermatogenesis by testosterone. According to Basil and Morley (2009), testosterone is involved in health and well-being. Testosterone is a steroid from the androstane class containing a keto and hydroxyl grouped at three and seventeen positions respectively. It is biosynthesized in several steps from cholesterol, converted in the liver to inactivate metabolites (Leutjen and Bauer, 2012). Research evidence (Roger and Hugh, 2008) shows that in adult males, levels of testosterone are about 7 to 8 times as great as in adult females. As the metabolism of testosterone in males is more pronounced, the daily production is about 20 times greater in men than in women (Southren, 2000). Testosterone is required for normal sperm development; it activates the genes found in Sertoli cells, which promote the differentiation of spermatogonia. It also regulates acute hypothalamic-pituitary-adrenal axis (HPA) response under dominance challenge (Southren, 2000).

In the literature, it is equally reported that the total levels of testosterone in the body range from 264 to 916 ng/dl in men aged 19 to 39 years (Vermeulen, 1996), while the mean testosterone levels in adult men have been reported as 630 ng/dl (Sperting et al., 2014). According to Vermeulen (1996), in women, mean levels of total testosterone have been put at 32.6 ng/dl. In women with hypergonadism, mean levels of total testosterone have been reported to be 62.1 ng/dl. By measurement, testosterone's bioavailable concentration is commonly determined using the Vermeulen calculation or more precisely using the modified Vermeulen approach, which considers the dimeric form of sex-hormone-binding globulin. According to Fletcher (2018), most people think of testosterone as a male sex hormone, but everyone requires a certain amount. A women testosterone levels naturally change throughout her life, during her menstrual cycle, and even at different times of the day. A woman with low testosterone does not produce new blood cells, main sex drives and does not boost levels of other reproductive hormones (Vermeulen, 1996).

Testosterone levels affect fertility, sex drive, etc. (Fletcher, 2018). Low testosterone can cause sleep disturbances, reduced sex drive, a decline in sexual satisfaction, vaginal dryness, irregular menstrual cycles, among others. According to Fletcher (2018), there are two main causes of low testosterone:

- Diminishing levels of the hormones as a normal result of menopause and
- Problems with the ovaries or the pituitary or adrenal glands.

A woman may have reduced levels of testosterone if her

ovaries have been removed, for example, or if she has adrenal insufficiency, which means that the adrenal glands do not work correctly. High testosterone levels in women can cause acne, deep voice, irregular periods, mood changes, loss of libido and reduction in breast size (Jayne, 2018).

Testosterone imbalances in a woman can affect their physical appearance and overall health (Jayne, 2018). Severely high levels of testosterone in women have been implicated as causing obesity in infertility. Underlying medical condition, such as congenital adrenal hyperplasia (CAH) is even said to be the cause of high testosterone in women. Congenital adrenal hyperplasia is a term given to a group of an inherited disorder that affects the adrenal glands. People with CAH lack one of the enzymes necessary to regulate the production of this hormone (sex hormone); so, they secrete too little cortisol and too much testosterone (Jayne, 2018). According to Jayne (2018), while there is no cure for CAH; most people with this condition can receive treatment that will reduce symptoms and improve their quality of life.

Testosterone, both in excessive and depleted states, has been implicated in female reproductive disorders. As such scrum testosterone measurements are frequently ordered by physicians in cases of sexual dysfunction and women with hirsutism (Ann and Robert, 2017). Commercially available testosterone has significant limitations in the female population. Furthermore, the measurement themselves do not always give enough information in patient diagnosis, treatment or prognosis (Ann and Robert, 2017).

Statement of the problem

People, the world over are faced with myriads of problems. Such problems could be marital, financial, social, or sexual. For the female population, their problem often relates to a lack of desire for sex and food. In other words, most women have lost interest in things that arouse their sexual desire thereby, making them suffer from sexual dysfunction (Sherri et al., 2017). A good example among them is menopausal women. While some women have lost interest in sexual matters, others excessively crave for such and become sex addicts. Another problem faced by the female population is difficulty in eating. Some women suffer from anorexia nervosa – loss of appetite for food. Still, some women eat excessively, thereby becoming a binge. Eating too much food at a time causes obesity and diabetes (Sherri et al., 2017).

Based on the foregoing problems, the present study sought to examine the effect of testosterone administration on the mating and eating behaviours of female albino rats. The following research questions were asked in this study:

1. Will female albino rats eat more or less after testosterone administration?
2. Will female albino rats with high testosterone treatment engage more or less in mating behaviour than those with low testosterone treatment?

In addition, two hypotheses were postulated and tested in this study:

H_{01}: Female albino rats will consume more food after the administration of testosterone than before the administration of testosterone.
H_{02}: Female albino rats will engage more in mating behaviour after the administration of testosterone than before the administration of testosterone.

Purpose of the study

The main purpose of this study was to examine the effect of testosterone administration on the eating and mating behaviours of female albino rats. Specifically, the study aimed at investigating the eating and mating behaviours of female albino rats before and after the administration of testosterone.

Scope of the study

Female albino rats were used in this study but the result of this academic effort would be extrapolated to the general female human population, regardless of tribe, race, colour, culture and discrepancies in their body frames. This implies that the study would dwell more on those who have some health-related problems bothering on their sexuality and eating behaviour. Invariably, the female human population was studied in terms of their response to testosterone in the area of their mating and eating behaviour using female albino rats in the laboratory.

Significance of the study

This study would be useful in creating awareness about the effect of testosterone on women sexual and eating behaviours for those having any form of disorder in achieving these basic physiological needs (sex and food), especially, when some synergies are discovered. The knowledge to be gained from this study would significantly helped the human population understand how adaptive the female species could be. However, it would also help reveal to the world some biological reasons some women behave the way they do when exposed to some content of hormone (testosterone) at certain stages of their lives.

Additionally, the study is significant in the sense that the female rats have been proposed as models in the study of appetitive sexual behaviour, and sexual motivation is a valid animal model of sexual desire in the human female. Appetitive behaviour decreases with age in female rats, similar to the decline in sexual desire experienced by

postmenopausal women. The female rats may therefore be useful models to study the effect of testosterone on sexual behaviour. Likewise, sexual behaviour and eating behaviour to a reasonable degree is also appetitive, and since sex and food are all basic needs, it follows that if the female rats have been proposed as models in the study of appetitive sexual behaviour, it will also prove relevant when used to study eating behaviour in female humans especially when extrapolated to the human population.

METHODOLOGY

Study location

The study was conducted at the University of Uyo, Uyo. The University of Uyo is a multi-campus institution, hence parts of the research process took place in the Department of Chemical Pathology, University of Uyo Teaching Hospital (UUTH), and the Animal House in the Faculty of Pharmacy. Parts of the study were also carried out in Annex Campus, Ikpa Road, using the animal laboratory of the Faculty of Basic Medical Sciences.

Subjects

The subjects used for the study were twelve (12) sexually mature Wister albino rats. Three (3) of the Wister albino rats were males, while nine (9) were females. The age range of the Wister albino rats was between 10 and 12 weeks, hence their mean age was 11 weeks. The albino rats were obtained from the animal laboratory in the Faculty of Pharmacy and housed for an experiment in the animal laboratory in the Faculty of Basic Medical Sciences, University of Uyo, Uyo.

Housing materials used

Four (4) wooden cages were used to house the Wister albino rats for the experiment. Three of the wooden cages were 65 cm x 45 cm x 25 cm in size, while one was of 45 cm x 35 cm x 15 cm capacity. Wood scraps (sawdust) were used to form their beddings; plastic feeding bottles were constructed using empty pen containers to form a hole through where water could flow, and stainless plates were used to serve their meals morning and evening.

The researchers also used dettol, izal and kerosene mixed, to sanitize the cages to drive away ectoparasites (like ticks). A special cup was used for collecting feed (chow) daily from the feed bag. The researchers also used weighing a scale to weigh the animal feed properly before serving them. A bag of feed (25 kg) called 'grower' was used throughout the experiment. 1 and 2 ml syringes were used for administration of testosterone and collection of blood samples for testosterone analysis. Plastic gloves (1 packet) were used for safety purposes, same with face masks to avoid or reduce the quantity of contaminated air inhaled into the system. During power outages, flashlights were often used as an alternative.

A set of instruments called 'cannula' was also used (the use of super glue to attach a needle to a feeding tube). During weighing periods, a wood stool was used as a platform where the scale was placed for proper weighing. Masking tape and three (3) different coloured marker pens were used to mark the rats and labelled the cages to differentiate them; all the cages were placed on a wooden table constructed for that purpose. A bottle of testosterone propionate (25 mg/kg) was used throughout the experiment and it was mixed with 100 mg of corn oil to form the substance of administration. A measuring cylinder (100 ml) was used to accurately measure the corn oil, and a beaker (100 ml) was also used with a spatula to properly mix both liquids into a fine solution.

Brooms, packers, buckets and plastic baskets were used during laboratory, cages and equipment cleaning, and testosterone administration. An inbuilt water sink in the laboratory was always available for thorough washing of hands after work. The animals were killed during the experiment using desiccators, chloroform (2 ml), cotton wool, a board, a pair of scissors and dissecting set. At the bottom of the desiccators was cotton wool that absorbed the chloroform when some quantities dropped into it. The animals were thrown into the desiccators; inhaling the chloroform weakened and made the animals unconscious. At this point, they were brought out and placed on the board and a pair of scissors was used to open their stomach for blood collection (1 to 2 ml), using 2 ml syringe per rat, but the blood samples were collected in plane sample bottles.

Materials used to determine testosterone level of the female Wister albino rats

The materials use to determine testosterone level of the female Wister albino rats were provided with test kits and components. They include:

1. Goat anti-rabbit igle-coated microtiter wells (96 wells).
2. Testosterone reference standards 0, 0.1, 0.5, 2.0, 6.0 and 18.0 ng/ml liquids, (0.5 ml each) ready for use.
3. Rabbit anti-testosterone reagent (7 ml).
4. Testosterone-HRP conjugate reagent (12 ml).
5. TMB substrate (12 ml).
6. Stop solution (12 ml).
7. Wash buffer concentrate (50 x 15 ml).Sample Dihient (optional).
8. APDIA Micro-Flate ELISE Reader.

Procedure

To have access to testosterone, the researchers went to the National Drug Law Enforcement Agency (NDLEA)

located along Nwaniba Road, Uyo, Akwa Ibom State. At the NDLEA, the researchers were told that testosterone propionate (synthesized hormone) was out of stock, but they were told that they could buy it in any pharmacy, which they did with a permission from NDLEA. The corn oil (100 ml) was provided by the laboratory scientist in the Faculty of Pharmacy where the study was conducted. He also mixed the testosterone propionate with the corn oil to arrive at the final solution, and also determined the various dosages for the different treatments. The researchers were allowed access to the animal house (laboratory) in Annex Campus and four (4) cages made available by the animal house attendant. The cages were all sanitized before the twelve (12) Wister albino rats were obtained from the animal house. The twelve (12) albino rats – 3 males and 9 females were grouped and labelled for easy recognition. The females were grouped in threes and labelled group 1 (low dose), group 2 (medium dose), group 3 (high dose), while the 3 males were housed in one cage and labelled accordingly.

The rats were fed and given water daily (morning and evening) without any form of measurement and observation, with their cages cleaned up every two days. The experimenters called this period the acclimatization period and it lasted for two weeks. After the first nine days, two female albino rats were sampled from the cages – group 1 (rats B and C), group 2 (rats D and E), and group 3 (rats G and H) for collection of blood samples to enable the researchers (with the assistance of the laboratory scientist) determine their testosterone levels before administration of testosterone propionate. The blood samples were collected using a 1 ml syringe, between 1 ml and 2ml of blood was taken from each of the sampled rats and placed in six (6) plane sample bottles. These blood samples were taken to the chemical pathology department of UUTH for analysis (to determine the level of testosterone in each rat). The animals were given five (5) days to recover and be free from pain before the end of the acclimatization period of two weeks. After this period, one week was used to observe the eating and mating behaviours of the female albino rats.

Before 6.50 am, the researchers made sure that the properly weighed food pellets were served to the rats. The researchers also made sure that the rats' food was measured in 100 g together with water before serving them and then returned after eleven (11) hours to weigh the remnants of the food to enable them to determine the quantity of the food pellet consumed by the rats. This action was repeated daily throughout the observation period. In the study, a comparison was made between eating behaviour before administration and after administration for daytime observation only because the nighttime observation was disrupted by observation of mating behaviour for four (4) hours each night.

Since the Wister albino rats are part of the rat family and rats generally are nocturnal animals, and in conjunction with the findings that testosterone level rises in the morning hours (Nyby, 2007). Observation was done late at night, for two hours (10:00 to 12:00 pm) and early in the morning, for two hours (4:00 am to 6:00 am) when testosterone level is believed to be high. Mating behaviour was quantified by counting the number of times the female albino rats received the male albino rats (receptivity), the frequency of mounting, the rate of lordosis and the frequency and length of pairing with the male albino rats. Each of the aforementioned mating behaviours was allocated 2 points, while every resistance put up by the female animal, or any indifferent attitude received a zero score. Twenty minutes (20) before the time of observation, the researchers would bring down the four cages containing the different groups of albino rats (group 1, group 2 and group 3 for the females while the remaining one was for the stimulus males) and place them on the floor for clear observation. Five (5) minutes to the time of observation, the researchers placed each of the stimulus males into each of the cages containing three female albino rats and allowed a time interval of 3 minutes before observation. During each of the two hours observations (late at night and early in the morning), the plates containing their food and their water bottles, were removed and placed back after observation.

Day 1, male rats M, N and O were placed in cage 1, 2 and 3 respectively.
Day 2, male rats N, O and M were placed in cages 1, 2 and 3 respectively.
Day 3, male rats O, M and N were placed in cages 1, 2 and 3 respectively.
Day 4, male rats M, N and O were placed in cages 1, 2 and 3 respectively.
Day 5, male rats N, O and M were placed in cages 1, 2 and 3 respectively.
Day 6, male rats O, M and N were placed in cages 1, 2 and 3 respectively.
Day 7, male rats M, N and O were placed in cages 1, 2 and 3 respectively.

With this, the researchers ensured that all the female groups received the three (3) stimulus males with different potency to eliminate biases. At the end of the two hours, the male rats were withdrawn from the female cages and taken back to their cages until the next observation time.

For the procedure of administration, 1 ml (25 mg) of testosterone propionate was used as a standard measure for calculation and administration. To determine both the low dosage and the high dosage, half of 1 ml became very important in the sense that 0.5 ml was subtracted from 1 ml to have 0.5ml for low dosage and the same 0.5 ml was added to 1 ml to have 1.5 ml for high dosage, while 1 ml was used as the medium dosage. To obtain the stock solution, 100 ml of corn oil was mixed with 25 mg of testosterone propionate. Mathematically, 25mg/100ml = 100ml/100. The end result becomes 0.25 mg/ml (stock solution).

Table 1. Effects of testosterone administration on the eating and mating behaviours of female albino rats.

Variables	N	Mean (Eating behaviour)	Mean (Mating behaviour
Pre-administration	9	36.77	34.44
Post-administration	9	85.44	44.88
Level of administration			
Low	3	29	33.33
Medium	3	97.66	44.66
High	3	129.6	56.66
Total	9	85.44	44.88

Table 2. Summary of paired sample test showing differences in eating and mating behaviour of female albino rats before and after the administration of testosterone.

Variables	Treatment	$\bar{x}$	t-value	df	Sig.
Eating behaviour	Pre-administration Post- administration	36.77 85.44	-3.091	8	<0.05
Mating behaviour	Pre-administration Post- administration	34.44 44.88	-2.74	8	<0.05

Design of the study

A within-group design was adopted for the study. This design was adopted because the same set of female albino rats used during pre-test observation was also used for the post-test observation. This type of design gives room for comparison between two or more treatment levels with the same subjects in an experiment.

Statistics

Paired sampled t-test and multivariate analysis of variance (MANOVA) were used to analyse data generated from the experiment. One-way MANOVA was used because there were two dependent variables, and it is suitable for comparing means of samples.

RESULTS

Table 1 shows that female albino rats administered with a high level of testosterone had higher mean scores than those administered with either medium level or low level of testosterone (X = 129.60 vs 97.66 vs 29.00 respectively). This refers that female albino rats administered with a high level of testosterone consumed more food than those administered with either a medium level or a low level of testosterone. Table 1 further reveals that female albino rats administered with a high level of testosterone had higher mean scores than those administered with either medium or low level of testosterone (X = 56.66 vs 44.66 vs. 33.33 respectively). This implies that female albino rats administered with a high level of testosterone engaged more in mating behaviour than those administered with either medium level or low level of testosterone.

Results presented in Table 2 indicate that there was a statistically significant difference in the eating behaviour of female albino rats before and after the administration of testosterone ($t= -3.091$; $p<0.05$). This is seen in the significance of the mean scores where the rats scored higher after the administration of testosterone than before the administration of testosterone. This means that female albino rats consumed more food after the administration of testosterone than before the administration of testosterone.

Results presented in Table 2 also revealed that there was a statistically significant difference in the mating behaviour of albino rats before and after the administration of testosterone ($t=-2.74$; $p<0.05$). This implies that female albino rats engaged more in mating behaviour after the administration of testosterone than before the administration of testosterone. Thus, the hypothesis which stated that female albino rats would engage more in mating behaviour after the administration of testosterone than before the administration of testosterone was accepted.

Results presented in Table 3 indicate that the administration of testosterone had a significant effect on the eating and mating behaviour of female albino rats [$F= (2, 8)$ 21.57; $p<0.05$] and [$F = (2, 8)$ 7.706; $p<0.05$] respectively. Therefore, the third hypothesis, which stated that the level of testosterone administration would have a statistically significant effect on the eating and mating behaviours of albino rats was confirmed.

Table 3. Summary of MANOVA showing effects of testosterone administration on eating and mating behaviour of female albino rats.

Source	Dependent Variable	Sum of squares	Df	Mean square	F.	Sig.
Testosterone level	Eating Behaviour	15872.889	2	7936.444	21.573	0.002
	Mating Behaviour	816.889	2			
	Eating Behaviour	18080.222	8	408.444	7.706	0.022
	Mating Behaviour	1134.889	8			

Table 4. Determined testosterone level of sampled female Wister albino rats before administration.

Sampled ID	Testosterone concentration (ng/ml)	Testosterone absorbent
Pre-test low dosage 1	0.00	2.722
Pre-test low dosage 2	0.00	2.540
Pre-test medium dosage 1	0.00	2.609
Pre-test medium dosage 2	0.00	2.609
Pre-test high dosage 1	4.20	0.248
Pre-test high dosage 2	4.50	0.239

Table 5. Determined testosterone level of sampled female Wister albino rats after administration.

Sampled ID	Testosterone concentration (ng/ml)	Testosterone absorbent
Pre-test low dosage 1	0.20	1.251
Pre-test low dosage 2	0.014	1.679
Pre-test medium dosage 1	4.80	0.224
Pre-test medium dosage 2	28.00	0.001
Pre-test high dosage 1	19.7	0.069
Pre-test high dosage 2	4.7	0.229

Range of control = 0 – 2 ng/ml.

DISCUSSION

From the findings, the first hypothesis which stated that female albino rats would consume more food after testosterone administration than before testosterone administration was confirmed (t= -3.091; $p<0.05$). This implies that testosterone can make female albino rats eat more compared to when they were not administered with testosterone. This result is consistent with the findings of Sherri et al. (2012) who reported that when SILASTIC brand capsule was administered on aged ovary-intact female rats craved for food, sexual solicitation and lordosis were facilitated by the highest testosterone propionate dose. The present study also revealed that female albino rats that received a high dosage of testosterone ate more (X = 129.6) than female albino rats that received both low dosage (X = 29.00) and those that received medium dosage (X = 97.66). But then, there is something about female albino rats in the high-dose group (3), in the sense that even before testosterone administration, they ate more than the animals (female albino rats) in both groups 1 (Low dose) and group 2 (medium dose). Therefore, in the views of present researchers, female albino rats that received a high level of testosterone treatment ate more (X = 129.6) than those in the low-level treatment group (X=29.00). Individual differences play a role here, even among lower animals.

The second hypothesis which stated that female albino rats would engage more in mating before after the administration of testosterone than before the administration of testosterone was accepted (t= -2.74). Also, the mean score of post-administration (X = 44.88) was higher than pre-administration mean score (X = 34.44). Still from the findings, female albino rats that received high treatment levels (dose) engage more in mating behaviour (X= 56.66) than those that received both

low treatment levels (X = 33.33) and medium treatment levels (X= 44.66). However, the result of the present study equally shows that female albino rats that receive high testosterone levels engaged more in mating behaviour than those that received medium level testosterone administration. The simple explanation we can give is that the female albino rats that ate more after receiving a high level of testosterone administration, must have been starved sexually for a long time, so little administration of testosterone injection motivated them to engage more in sexual behaviour to satisfy their sexual urge. The result of this study is consistent with Sherri et al. (2012) finding that SILASTIC brand capsule injection made female albino rats solicit for more sex.

Statistically, there existed a significant difference in both the eating and mating behaviours of the female albino rats after administration of testosterone. These findings are in line with the finding of Robertson et al. (2009) who found out that seminal fluid made flies eat more and lay more eggs.

Conclusion

It is clear from the findings of this study that the research questions earlier asked have been answered in the affirmative. The result of the study showed that female albino rats eat more after testosterone administration. It also showed that female albino rats with a high dosage of testosterone administration engaged more in mating behaviour than those that received low treatment (dosage).

In summary, considering the use of testosterone therapy to enhance eating and mating behaviours in humans, and in connection with the findings above, this study recommends that married women who have any or all of the health challenges aforementioned, should consider testosterone replacement therapy for better results. This should, however, be used moderately.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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